

# Warm-up

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1. How many symmetry lines does a regular hexagon have? How many centers of symmetry?

*6 symmetry lines, 1 center of symmetry*

2. How many symmetry lines does an isosceles triangle have? How many centers of symmetry?

*3 symmetry lines, 0 centers of symmetry*

3. Draw a figure with more than one center of symmetry.

*Try  $y = \sin(x)$  or  $y = x$*



# Section 3-4

*Symmetries of Graphs*



*Reflection-symmetric: A figure that can be mapped onto itself by a reflection over a line*

*Axis/Line of symmetry: The line that a reflection-symmetric figure is reflected over*



*Symmetry to point P/point symmetry ( $180^\circ$ -rotation-symmetric): A figure that can be mapped onto itself under a  $180^\circ$  rotation around point P*

*Center of symmetry: The point P that a  $180^\circ$ -rotation-symmetric figure is rotated around*

*Symmetric with respect to an axis: When a graph is a reflection over either the x-axis or y-axis*



# Example 1

*Prove that the graph of  $y = x^2$  is symmetric to the  $y$ -axis.*

*We need to show that all points map onto a corresponding coordinate where the  $x$ -coordinate is the opposite, and the  $y$ -coordinate is the same.*

*Suppose  $(x, y)$  is on the graph.*

*Then  $y = x^2$ .*

*Plug in  $-x$  for  $x$  and we get  $y = (-x)^2$ .*

$$(-x)^2 = x^2.$$

*So when  $(x, y)$  is on the graph, so is  $(-x, y)$ .*



*Symmetric to the origin:*

*A figure that is  $180^\circ$ -rotation-symmetric around the  
origin*



## Example 2

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*Prove that the graph of  $y = x$  is symmetric to the origin.*

*We need to show that all points map onto a corresponding coordinate where the  $x$ -coordinate and  $y$ -coordinate are opposite.*

*Suppose  $(x, y)$  is on the graph.*

*Then  $y = x$ , so  $-y = -x$ .*



*Power function: A function in the form  $y = x^n$ ,  
where  $n \geq 2$*

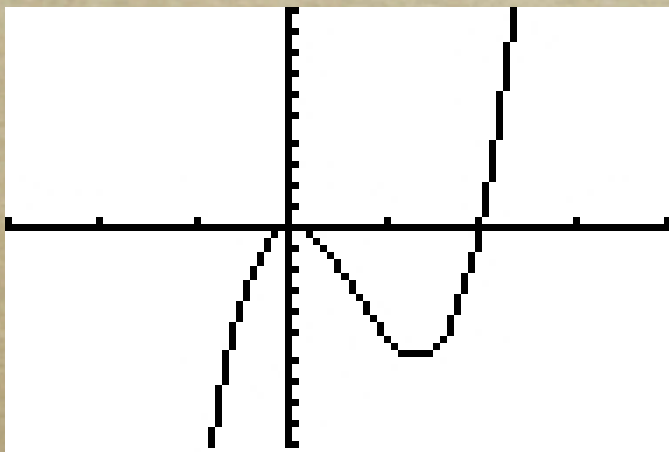
*Even function: A power function where  $n$  is  
even;  $\forall x$  in the domain,  $f(-x) = f(x)$*

*Odd function: A power function where  $n$  is odd;  
 $\forall x$  in the domain,  $f(-x) = -f(x)$*



# Example 3

*Does  $f(x) = 5x^3 - 10x^2$  have line symmetry or point symmetry? How do you know?*



*It has point symmetry.  
Can you find the point?*

$$\left(\frac{2}{3}, \frac{-80}{27}\right)$$



*The Graph-Translation Theorem  
helps us to figure out where  
asymptotes are.*



# Example 4

*Give equations for the asymptotes for the following graph:*

$$h(x) = \frac{3}{x + 2} + 4$$

*This is a translated hyperbola.*

*The parent function of a hyperbola has asymptotes at  $x = 0$  and  $y = 0$ .*

*The translation is  $(x - 2, y + 4)$ .*

*$x = -2$  and  $y = 4$*



# Homework

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